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PEWAUKEE LAKE, WAUKESHA COUNTY, WISCONSIN.
EPA REGION V

Pacific Northwest Environmental Research
Laboratory

Prepared for:

National Environmental Research Center
Wisconsin Department of Natural Resources
Wisconsin National Guard

July 1975

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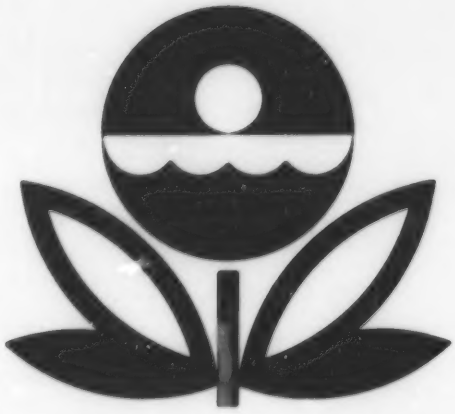

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT
ON
PEWAUKEE LAKE
WAUKESHA COUNTY
WISCONSIN

EPA REGION V

WORKING PAPER No. 73

WITH THE COOPERATION OF THE

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

AND THE

WISCONSIN NATIONAL GUARD

JULY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conduct of the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

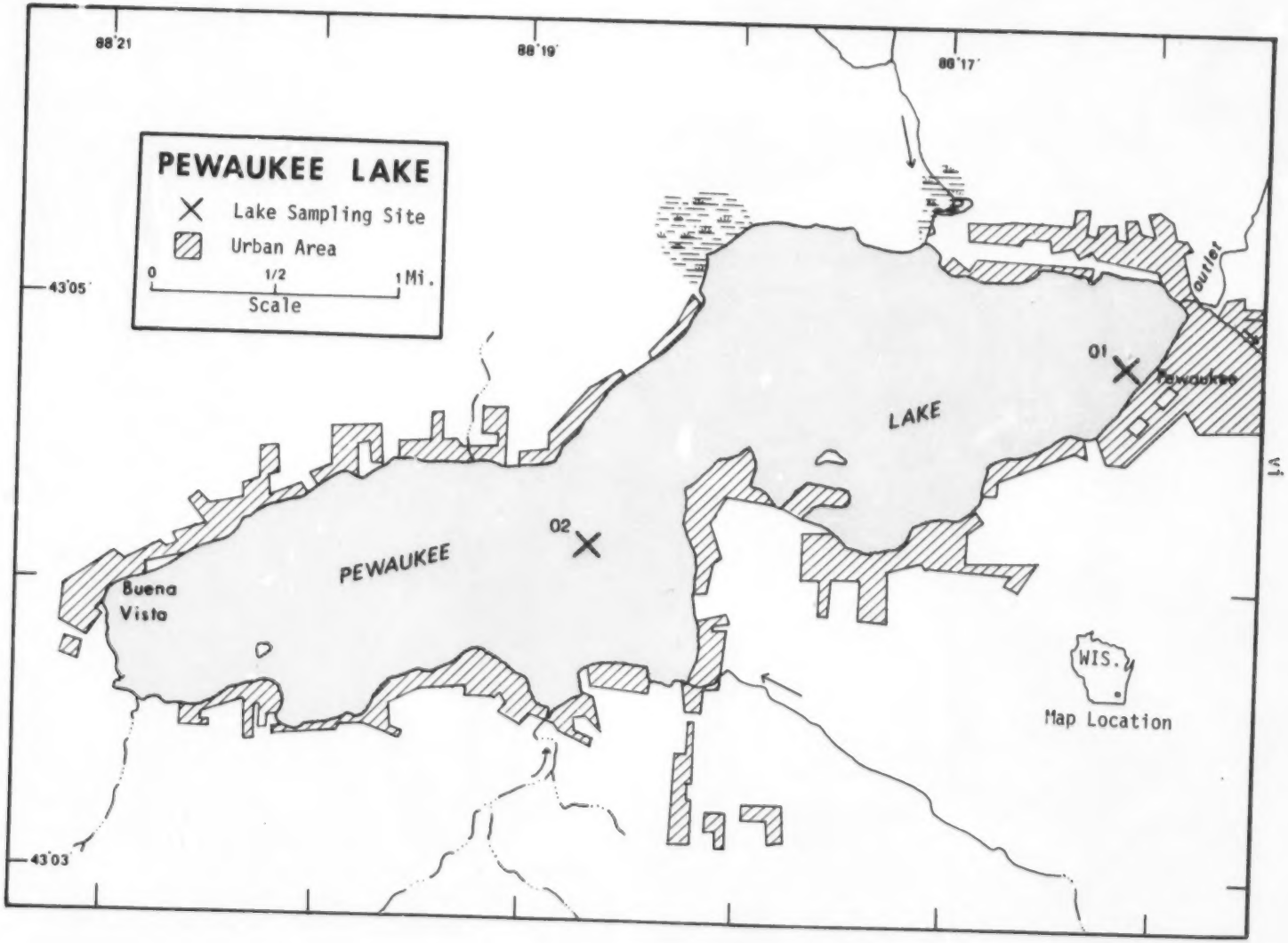
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

LAKE NAME	COUNTY
Altoona	Eau Claire
Beaver Dam	Barron
Beaver Dam	Dodge
Big Eau Pleine	Marathon
Browns	Racine
Butte des Morts	Winnebago
Butternut	Price, Ashland
Castle Rock Flowage	Juneau
Como	Walworth
Crystal	Vilas
Delavan	Walworth
Eau Claire	Eau Claire
Geneva	Walworth
Grand	Green Lake
Green	Green Lake
Kegonsa	Dane
Koshkonong	Jefferson, Rock, Dane
Lac La Belle	Waukesha
Middle	Walworth
Nagawicka	Waukesha
Oconomowoc	Waukesha
Okauchee	Waukesha
Petenwell Flowage	Juneau
Pewaukee	Waukesha
Pigeon	Waupaca
Pine	Waukesha
Poygan	Winnebago, Waushara
Rock	Jefferson
Rome Pond	Jefferson, Waukesha
Round	Waupaca
Shawano	Shawano

LAKE NAME	COUNTY
Sinnissippi	Dodge
Swan	Columbia
Tainter	Dunn
Tichigan	Racine
Townline	Oneida
Trout	Vilas
Wapogassett	Polk
Wausau	Marathon
Willow	Oneida
Winnebago	Winnebago, Fond Du Lac, Calumet
Wisconsin	Columbia
Wissota	Chippewa
Yellow	Burnett


88°21'
88°19'
88°17'
43°05'
43°03'
PEWAUKEE LAKE
Lake Sampling Site
Urban Area
0
1/2
1 Mi.
Scale
Outlet
01
Pewaukee
LAKE
02
PEWAUKEE
Buena
Vista
WIS.
Map Location

PEWAUKEE LAKE

STORET NO. 5557

I. INTRODUCTION

Pewaukee Lake was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Tributaries and nutrient sources were not sampled, and this report relates only to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data, field observations, and reports of others (Ketelle and Uttormark, 1971; Poff and Threinen, 1963; Poff et al., 1970) indicate Pewaukee Lake is eutrophic.

Of the 46 Wisconsin lakes studied, 13 had less mean total phosphorus, 15 had less mean dissolved phosphorus, 17 had less mean inorganic nitrogen, 27 had less mean chlorophyll a, and 16 had greater mean Secchi disc transparency. Dissolved oxygen was depleted in the hypolimnion in August, 1972.

Survey limnologists reported heavy growths of submerged aquatic vegetation in the shallow areas of the lake and noted light algal blooms in June and November. The lake has a history of efforts to chemically control algae and weeds (Lueschow, 1972; Lueschow et al., 1970).

In their comprehensive report, Poff et al. (1970) noted that unsewered subdivisions bordering Pewaukee Lake were contributing to the deteriorating water quality because of permeable soils and septic tank disposal systems (dwellings on the lake shore totaled 609 units in 1970). At this time, a sanitary district has been formed at the lake, and as soon as Federal funds are available, an interceptor will be constructed to serve lake-shore housing as well as the Village of Pewaukee; wastes will be conveyed to an expanded Brookfield tertiary wastewater treatment plant (Schraufnagel, 1975).

B. Rate-Limiting Nutrient:

Possibly because of sample contamination, there was a 121% gain in inorganic nitrogen in the algae assay sample between the time of collection and the beginning of the assay. This nitrogen gain shifted the limiting nutrient from nitrogen in the lake to phosphorus in the sample, and the assay results are not representative of conditions in the lake when the sample was collected.

The lake data indicate nitrogen limitation in June (N/P = 7/1) and November (N/P = 5/1) but phosphorus limitation in September (N/P = 18/1).

III. LAKE CHARACTERISTICS

A. Lake Morphometry*:

1. Surface area: 2,493 acres.
2. Mean depth: 14.8 feet (based on area and volume).
3. Maximum depth: 45 feet.
4. Volume: 36,863 acre-feet.
5. Mean hydraulic retention time: 4.2 years.

B. Precipitation**:

1. Year of sampling: 38.7 inches.
2. Mean annual: 30.7 inches.

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* Poff et al., 1970.
** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Pewaukee Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and usually from a number of depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 4 feet at station 1 and 36 feet at station 2.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

		FALL VALUES		
Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	7.2	7.4	7.5	7.5
Dissolved oxygen (mg/l)	7.6	10.2	10.7	11.0
Conductivity (μmhos)	460	470	470	480
pH (units)	8.4	8.4	8.4	8.5
Alkalinity (mg/l)	167	172	169	191
Total P (mg/l)	0.017	0.026	0.028	0.031
Dissolved P (mg/l)	0.011	0.015	0.016	0.017
NO_2 + NO_3 (mg/l)	0.030	0.040	0.030	0.080
Ammonia (mg/l)	0.030	0.038	0.030	0.070
		ALL VALUES		
Secchi disc (inches)	36	68	72	84

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/21/72	1. Chroococcus	1,566
	2. Merismopedia	1,024
	3. Marssoniella	994
	4. Dinobryon	783
	5. Cryptomonas	346
	Other genera	1,055
	Total	5,768
08/19/72	1. Dinobryon	470
	2. Chroococcus	297
	3. Anabaena	282
	4. Microcystis	224
	5. Synura	159
	Other genera	428
	Total	1,860
11/10/72	1. Anabaena	1,306
	2. Dinobryon	834
	3. Flagellates	779
	4. Melosira	452
	5. Scenedesmus	352
	Other genera	2,257
	Total	5,980

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/21/72	01	23.7
	02	9.0
08/19/72	01	7.7
	02	7.0
11/10/72	01	10.4
	02	36.1

V. LITERATURE REVIEWED

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APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

555701
43 04 48.0 088 16 06.0
PEWAUKEE LAKE
55 WISCONSIN

11EPALES 2111202
3 0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/21	05 44	0000	16.8	5.8	60	340	9.50	120	0.020	0.020	0.055	0.030
72/08/19	11 25	0000			72	360	9.55	127	0.050	0.040	0.024	0.015
	11 25	0004	25.9	7.7		365	9.45	125	0.080	0.080	0.031	0.021
72/11/10	14 10	0000	7.2	10.9	36	460	8.50	191	0.080	0.070	0.017	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/21	05 44	0000	23.7J
72/08/19	11 25	0000	6.7J
72/11/10	14 10	0000	10.4J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

555702
43 04 06.0 088 18 48.0
PEWAUKEE LAKE
55 WISCONSIN

11EPALES 2111202
3 0040 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/21	06 07	0000	16.1	8.8	84	400	8.60	160	0.040	0.050	0.025	0.012
	06 07	0015	20.2	8.0		420	8.10	157	0.050	0.060	0.031	0.028
	06 07	0025	16.0	5.4		420	8.10	165	0.050	0.190	0.025	0.012
	06 07	0035	9.1	0.4		440	7.60	180	0.030	0.810	0.133	0.119
72/08/19	11 40	0000			71	420	8.65	154	0.050	0.060	0.016	0.010
	11 40	0004	24.8	9.1		410	8.70	153	0.060	0.070	0.017	0.011
	11 40	0015	23.3	7.4		420	8.40	159	0.060	0.070	0.019	0.009
	11 40	0025	20.0	3.6		495	7.75	166	0.040	0.160	0.016	0.009
	11 40	0030	17.1	0.0		475	7.45	179	0.050	0.450	0.026	0.012
	11 40	0036	12.0	0.0		480	7.40	216	0.110	1.700	0.111	0.091
72/11/10	14 25	0000			84	480	8.40	167	0.030	0.030	0.027	0.014
	14 25	0004	7.5	10.7		470	8.40	169	0.040	0.040	0.030	0.016
	14 25	0015	7.5	11.0		470	8.40	168	0.030	0.030	0.031	0.017
	14 25	0020	7.5	10.6		470	8.40	168	0.030	0.030	0.026	0.015
	14 25	0028	7.5	7.6		470	8.40	169	0.030	0.030	0.028	0.016

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/21	06 07	0000	9.0J
72/08/19	11 40	0000	7.0J
72/11/10	14 25	0000	36.1J

J VALUE KNOWN TO BE IN ERROR